Finite-Element-Modeling of Poling Processes in Ferroelectric Components

Accounting For Charge Transport

H. Schwaab[1,2], M. Deluca[2,3], P. Supancic[3] and *M. Kamlah[1]

[1]Institute for Applied Materials, Karlsruhe Institute of Technology, Germany.
[2]Materials Center Leoben Forschung GmbH , Austria
[3]Institut für Struktur- und Funktionskeramik, Montanuniversität Leoben, Austria

*Corresponding author: marc.kamlah@kit.edu

Key Words: *Ferroelectric Ceramics, Poling, weak electric conductivity, non-linear finite element simulation*

Ferroelectric piezoceramics are an important class of smart materials for actuator, sensor and energy harvesting applications. In devices made of a polycrystalline ferroelectric material, piezoelectric properties have to be induced by the so-called poling process. This process may lead to residual stresses of significant magnitude which is of relevance to performance and reliability. Furthermore, the local distribution of the remanent polarization field resulting immediately after the poling process is not divergence free, in general. As consequence, severe electric depolarization fields may occur.

In this talk, we present a theory for the computation of poling processes in which is based on a constitutive model taking into account all electro-mechanically coupled ferroelectric and ferroeleastic hysteresis properties. In addition, this theory includes as a unique feature weak electric conductivity. We present various examples where the developed finite element tool has been used to compute poling processes in piezoceramic devices.

Keywords: Ferroelectric Ceramics, Poling, weak electric conductivity, non-linear finite element simulation